

Reducing Diagnostic Error in the ICU: A Novel Approach to Clinical Workflow—Visualization-Communication Integration

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Background and Aim: The ICU holds the critically ill who require continuous and coordinated monitoring and frequent intervention. ICUs have the highest annual mortality rate of any hospital unit (12-22%), impacting nearly one-quarter of all admissions [1, 2]. Although ICU patients are the most monitored, tested, and examined of all hospital patients, medical conditions are missed. Studies consistently demonstrate that the complexities of ICU clinical workflow and decision-making directly impact patient safety [3], in spite of the advances in health information technology (HIT) such as clinical decision support (CDS) and smart bedside devices. The ICU is an intensely challenging and complex clinical environment, with each provider being inundated with thousands of independent pieces of information daily from multiple sources [4] including HIT and electronic medical records (EMR) systems [5]. Previous research identifies nearly 80% of HIT “user error” from cognitive overload [6], resulting in incorrect use or user error in analyzing medical data and 91% of all medical mishaps resulting from inefficient team collaboration and communication among the intensivists [7]. Although the key factor of user error can be attributed to poor or inadequately designed system interfaces or interaction sequences, research shows that without a comprehensive understanding of the context in which care occurs, it is improbable that systemic factors leading to error will be adequately understood. Hence, it is imperative to understand the *underlying mechanisms of workflow error*, from which innovative HIT/CDS systems can be designed to more effectively improve ICU care delivery. Although CDS systems have received increasing attention in biomedical informatics and human-factors engineering literature, none has taken an integrated workflow approach that considers the following five factors as closely interrelated: (1) Patient status, involving continuous monitoring of patient organ function and vital sign function; (2) Patient data, such as that generated from treatment and bedside devices; (3) Medical cognition and cognitive resources of intensivists; (4) Communication among ICU team-members; and (5) Need for collaborative decision-making [8, 9]. The objective of our research is to investigate the root causes of and solutions to ICU error related to the effects of clinical workflow by:

Aim 1: Identifying and comparing existing medical cognitive load, workflow, clinician happiness/challenge, and team communication/collaboration in the context of HIT/CDS system use.

Aim 2: Constructing and validating several ICU workflow strategies that will be modeled for use with existing CDS systems, but primarily with the proposed novel VizCom technology, MIVA.

Aim 3: Designing and building the next stage of the (formally prototyped) VizCom application MIVA that integrates patient data visualization and intensivist inter-communication into a single mobile technology (US Patent 2/4/2014, #8,645,164).

Proposed Research: Based on two prior studies [10 11], our future work will identify intensivist cognitive load, workflow, and CDS system use by means of data collection methods that will take place in the ICUs of three Indianapolis hospitals, including: a) rapid ethnography: shadowing and group observation), b) self-reporting: survey, one-on-one interview, and social network analysis, and c) the experience sampling method. We propose a workflow model where MIVA will be used by intensivists who are spread across different zones, defined by location as: inside the ICU (Zone 1), inside the hospital but outside the ICU (Zone 2), and outside the hospital and on-call (Zone 3). According to our model, data will flow from bedside devices to the EMR to MIVA. The MIVA visualization-communication components will enable clinicians across all three zones to collaboratively diagnosis in unison.

Broader Impact and Conclusion: Based on the aforementioned research, we believe that clear, rapid, appropriate, and accurate communication is essential to developing human-centered technology that will deliver safe and effective patient care, from which seamless collaboration among clinical professionals is vital [12]. Existing studies consistently suggest that medical cognition should focus on complex social systems that constitute distributed knowledge, collaborative performance and clinical group workflow. Our project will inform the design of a clinical decision support tool that will provide the intensivists with capabilities for greater control of ICU data and inter-communication at the point-of-care.

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